Viscoelastic response of actin networks at intermediate distances

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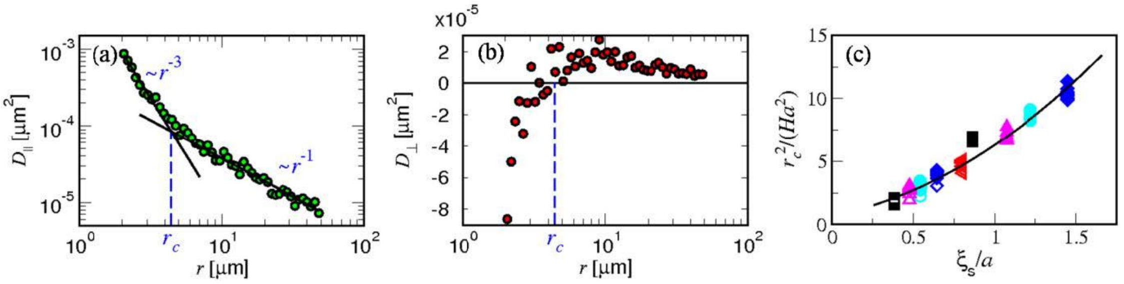
The viscoelastic response of actin networks is length- and time-scale dependent, encoding information on intrinsic dynamic correlations and mesoscopic structure. Over sufficiently large distances the network responds as a continuous medium, characterized by frequency dependent viscoelastic moduli. But how large should the distance be for this asymptotic bulk limit to hold?

We report the observation of a large-distance intermediate response in an experimental system of entangled F-actin gels. The tools of 1-point and 2-point microrheology were used to characterize the local and distance-dependent responses of the actin networks, respectively.

The 2-point response at intermediate distances, arising from the effect of mass displacement rather than momentum diffusion, is enhanced by the much softer local microenvironment of the tracers compared to the bulk properties of the gel. Consequently, the cross-over to the bulk behavior is pushed to surprisingly large distances, much larger than the mesh size, ξ_s, of the actin gel. Results from several networks with different mesh sizes will be presented, emphasizing this inherent property of complex fluids and its relation to ξ_s. This intermediate response has implications for the micro-scale dynamics of cells.



(a) Longitudinal and (b) transverse displacement correlations as a function of particle separation at lag time $\tau = 0.014 \sec for\ \xi_s = 0.44\ \mu m$ and tracer's particle radius $a = 0.55\ \mu m$. The cross-over distance r_c (blue dashed line) is defined at the intersection of the fitted dominant (r^{-1}) and subdominant (r^{-3}) power-law decays of $D_\parallel$. (c) Cross-over distance for different α and ξ_s , colors and symbols correspond to different ξ_s. Open (filled) symbols correspond to $=$ $0.55\ (0.245)\ \mu m$. All experimental results fall on a master curve once r_c^2 is normalized and present as a function of ξ_s/a . The solid line is a fit to the theoretical prediction.

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